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Mr. William F. Caton
Secretary
Federal Communications Commission
1919 M Street, N.W.
Room 222
Washington, D.C. 20554

87-268

Re: Ex Parte Briefing Slides in MM Docket No. 87-~~568~~, *Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service*

18 September 1996

Dear Mr. Caton:

Appended you will find a briefing document which we have prepared at the request of Saul Shapiro of the commission's Mass Media Bureau. This briefing document describes the fundamental concepts behind our recommendation of a "base layer" standard. An advanced television standard which is layered in resolution and frame rate differs in fundamental ways from the ACATS proposal which is being considered. This briefing document outlines the differences.

We will also be providing a number of copies directly to Saul Shapiro, in response to his request.

Respectfully submitted,

Gary Demos
President/CEO
DemoGraFX

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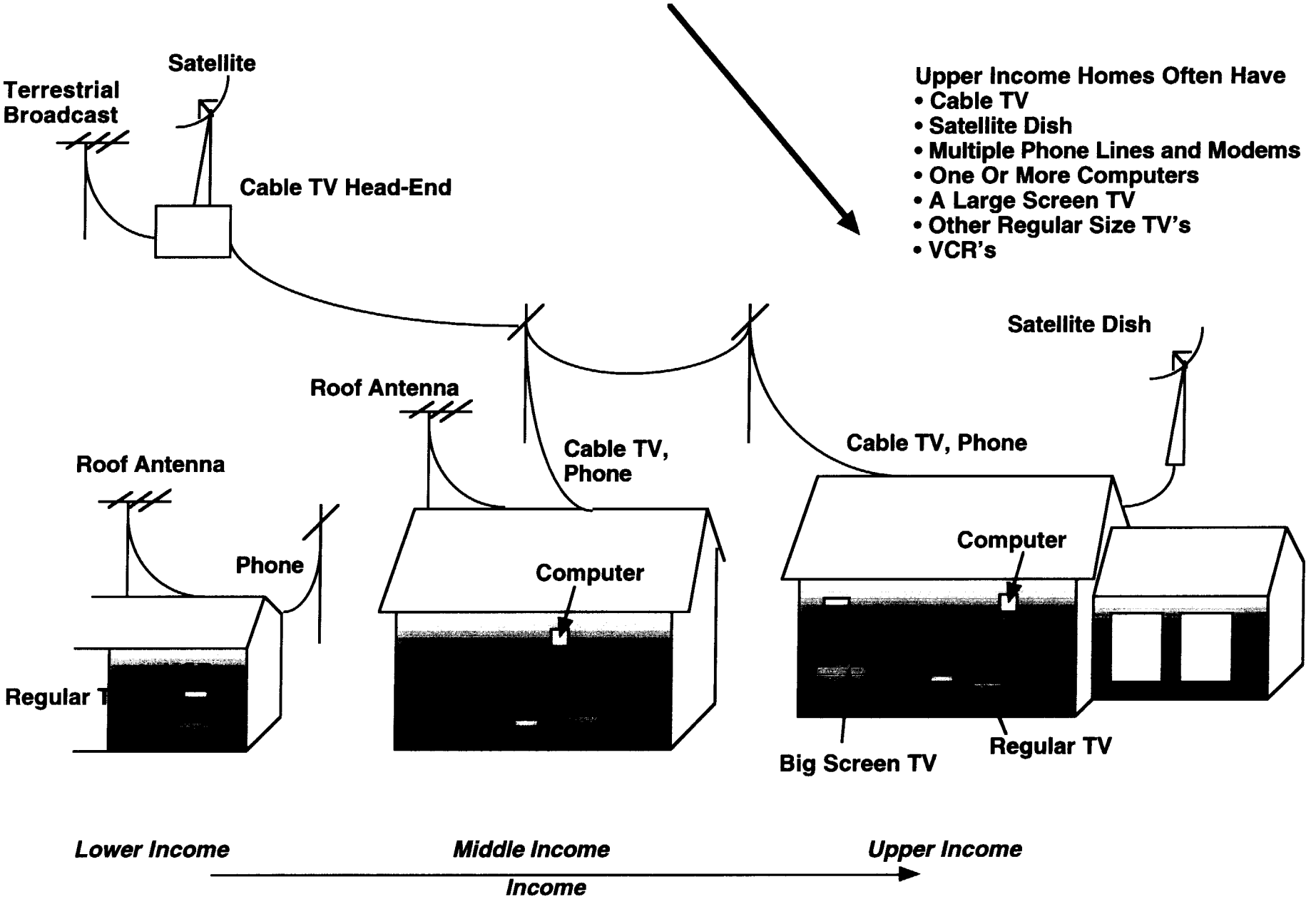
List ABCDE

DemoGraFX Briefing On The Base Layer Concept

This Briefing Will Cover The Following:

- **Who is HDTV's Target Consumer Income Group?**
- **How Can Digital Television Help Enable the N.I.I.?**
- **Can The Benefits Of An N.I.I. Reach Lower Income Homes?**
- **How Can Free Over-The-Air Broadcasting Play A Part?**
- **Why Is ATV Computer Compatibility Important?**
- **How Does A Layered System Let Consumers Decide?**
- **How Does Resolution Layering Work?**
- **Why Can't The ACATS System Be Layered?**
- **What Premises Underly The ACATS Cost Proposal?**
- **What Are The Benefits Of Resolution Layering?**
- **How Did We Achieve The Goal Of "Full Progressive Scan"?**
- **How Did We Decide On The Optimal Base Layer?**
- **Why Must Interlace Be Prohibited?**
- **What Frame Rate Problems Arise With ACATS Proposal?**
- **Why Is High Data Integrity Required?**
- **How Can The True Color Of Film Be Presented?**

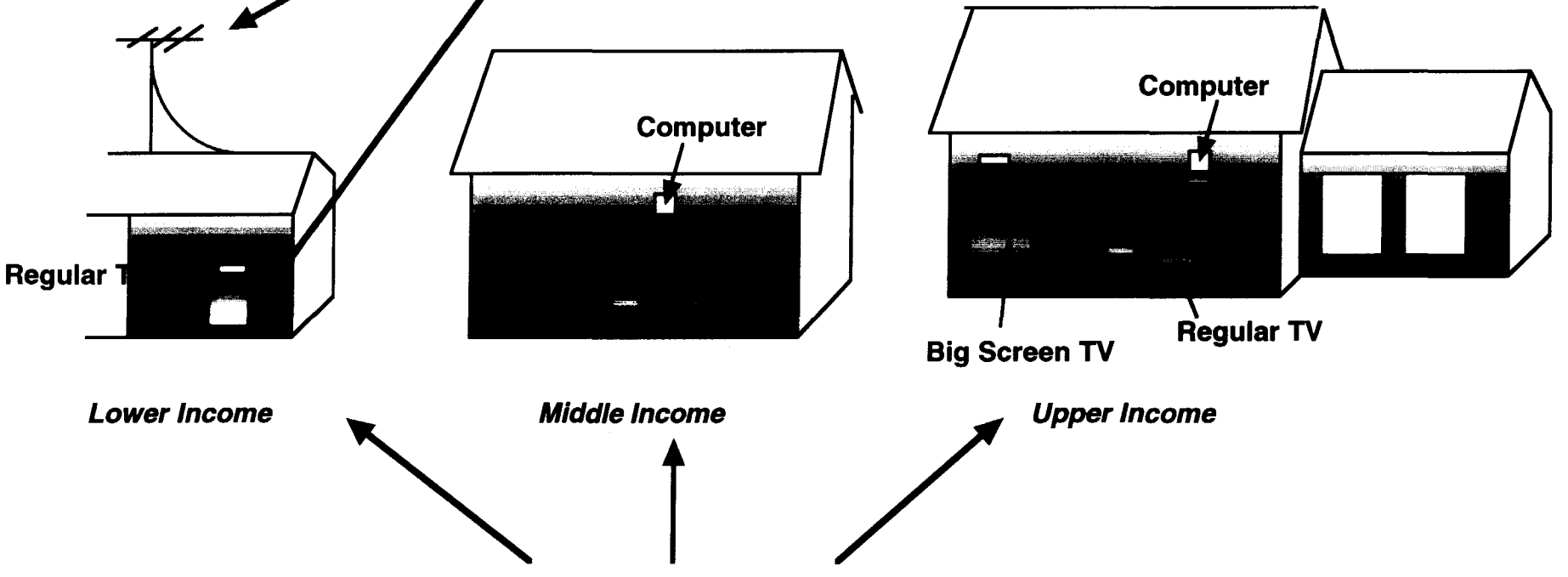
HDTV Is Intended For Upper Income Families



One Key Goal of a National Information Infrastructure Is to Reach Every Home

The Homes of Lower Income Families Have Televisions, But Not Computers

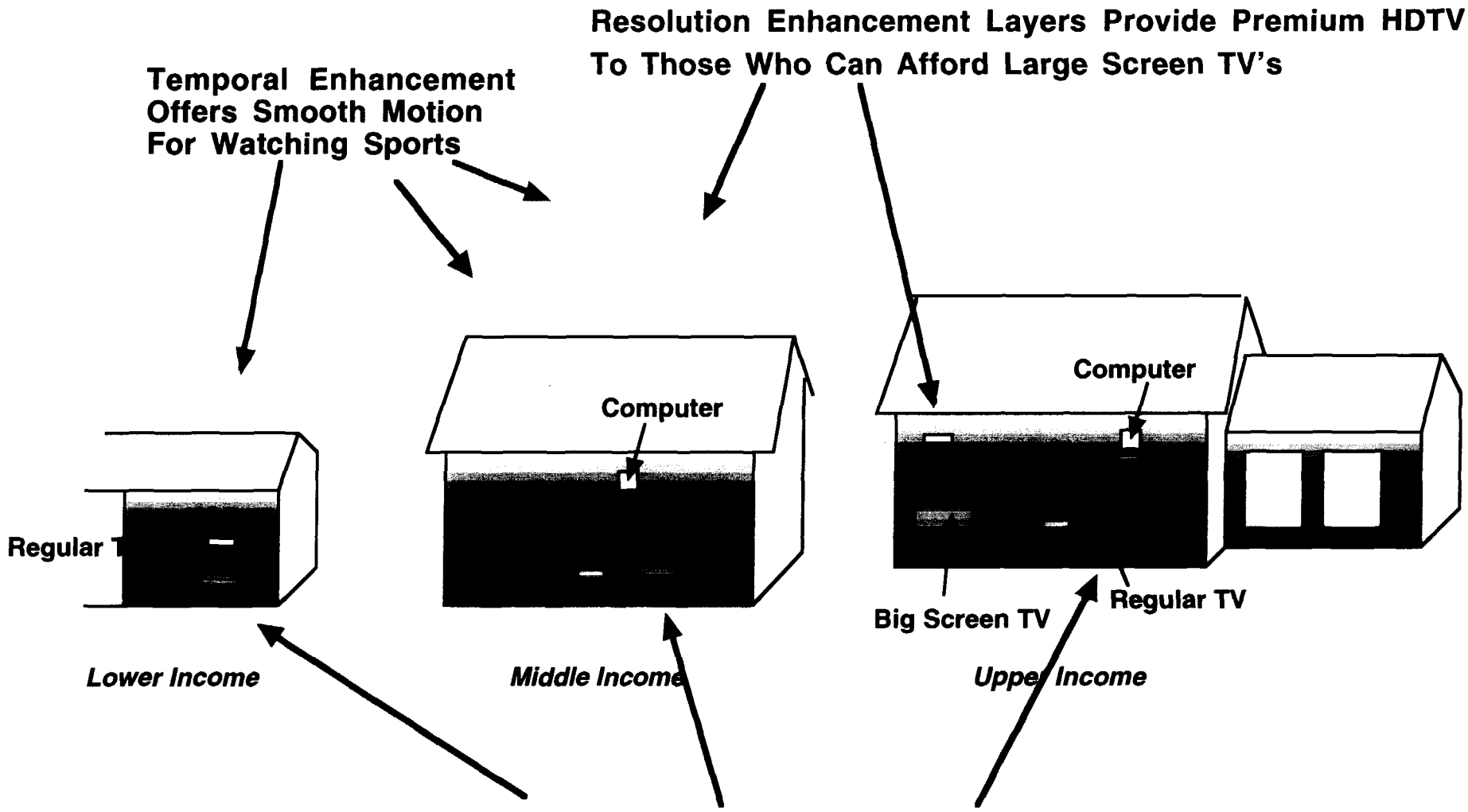
They receive Free-Over-The-Air Television But Not Cable



The Base Layer Format Provides Improved Digital Television To Every Home

Computer-Compatibility WIthin The Base Level Helps To Enable The N.I.I. Wherever There Is Digital Television

The Use Of Base Plus Enhancement Layers Lets Consumers Decide



The Resolution Base Layer Provides A Low Cost, High Quality TV Picture For TV Sets Smaller Than 35"

How Resolution Layer Works

Resolution layering adds

- an Image having a Base Resolution

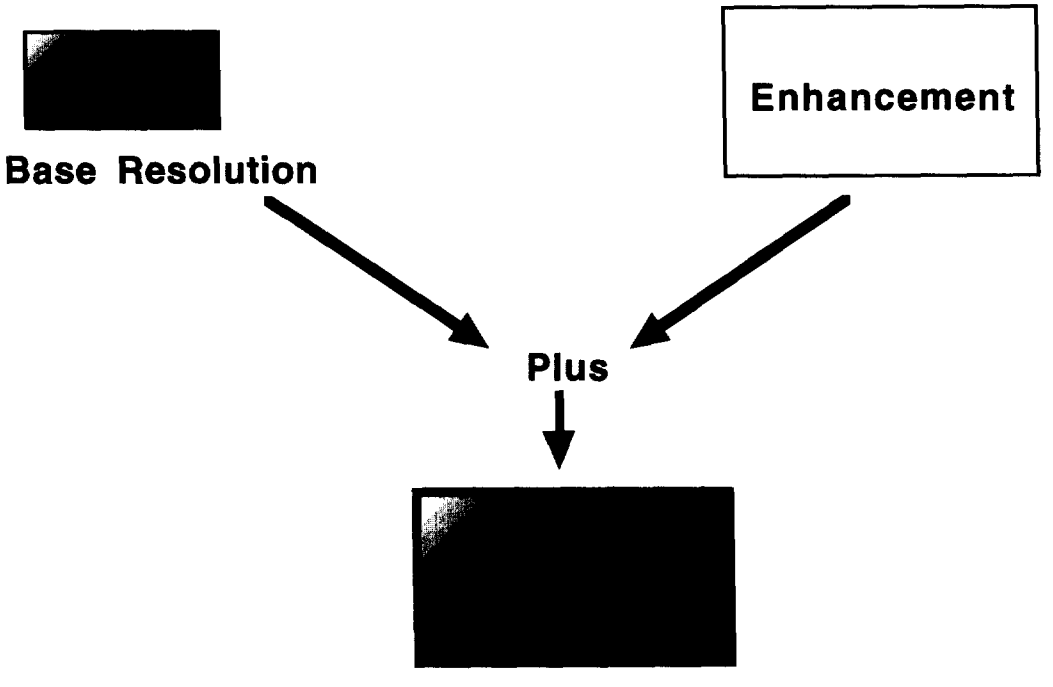
  to

- an Enhanced Resolution Image

  to create

- a New High Resolution Image

Resolution Layering Concept



Example:

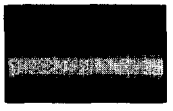
- Kodak Photo-CD (introduced in 1992)

ACATS Proposes Three Levels of Resolution:

480 lines	**(640 x 480, 704 x 480)**	**"Standard Definition"**
720 lines	**(1280 x 720)**	**"High Definition", Level 1**
1080 lines	**(1920 x 1080)**	**"High Definition", Level 2**

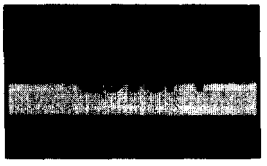
These three levels *could* be "layered" into a single system:

480 lines Base Layer



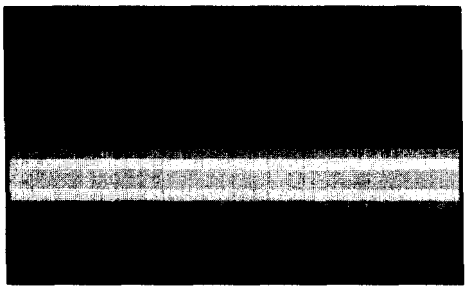
Plus 720 Line Enhancement

720 Line High Definition



Plus 1080 Line Enhancement

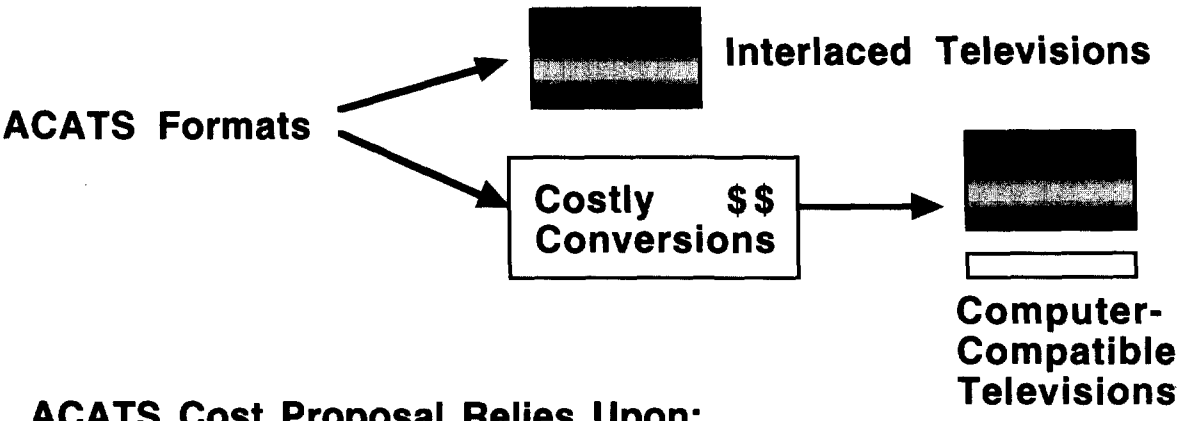
1080 Line High Definition



Except:

- **ACATS Proposal Is Not Structure This Way**
- **Interlaced Formats Do Not Layer Efficiently**
- **The Aspect Ratios (4:3 and 16:9) Do Not Match**

The ACATS cost proposal is biased against computer uses



ACATS Cost Proposal Relies Upon:

- Partial Decoding Of HDTV Formats (the "Hitachi" proposal)
- Low Cost De-Interlacing (using line averaging)
- 60 Hz Display Rate

However,

- The Hitachi proposal will result in poor image quality, poor coding efficiency, or both.
- Low cost de-interlacing results in severe image artifacts and impairments at all resolutions.
- 60 Hz is not acceptable as a display rate for computer-compatible displays

As A Result,

- Computer-compatible displays would show severe artifacts and very poor quality under the ACATS cost proposals
- The cost for computer-compatible receivers will be much higher than the ACATS cost estimates for acceptable image quality
- At a given cost, the computer-compatible receiver will always look worse on interlaced material than an equivalent cost interlaced receiver.

Image Layering Offers Many Benefits

Resolution Layering Requires:

- No use of interlace
- Aspect ratios must match in all layers
- Matching pixel spacings (i.e. square pixels)
- A Base Layer must always be present
- Resolution enhancement must be ignorable

Temporal (frame rate) Layering Requires:

- The base rate must not be lower than 36 Hz
- The display rate must be an integer multiple of frame rates
- Temporal enhancement (higher rates) must be ignorable

ACATS Violates ALL of these requirements

ACATS therefore loses all of the benefits of layering

DemoGraFX Has Found That Layering Offers:

- The base layer decoder cost is about 1/4 that of the decoder cost of HDTV

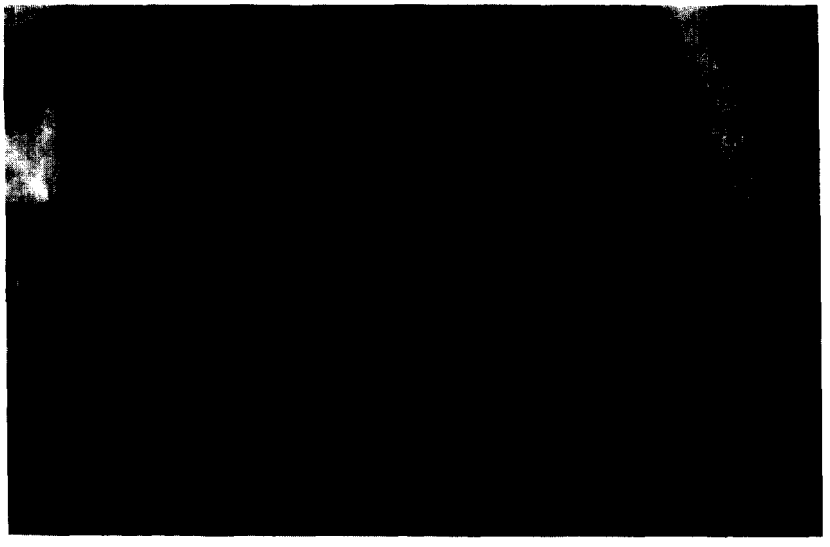
- One layered signal instead of numerous formats

- The ultimate HDTV goals can be achieved NOW (2048 x 1024 at 72 Hz within 18.5 mbits/second)

Interlaced Scan Lines

The Base Layer Cannot Make Use Of Interlace

It Is Easily Seen Why Interlace Does Not Form A Suitable Basis Upon Which To Build Enhancement Layers



Non-Interlaced

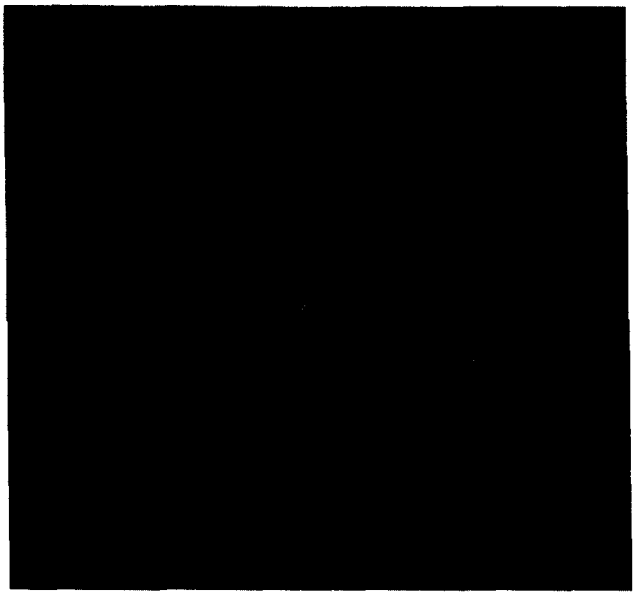
Interlaced

Properties of Interlace Which Make It Unsuitable

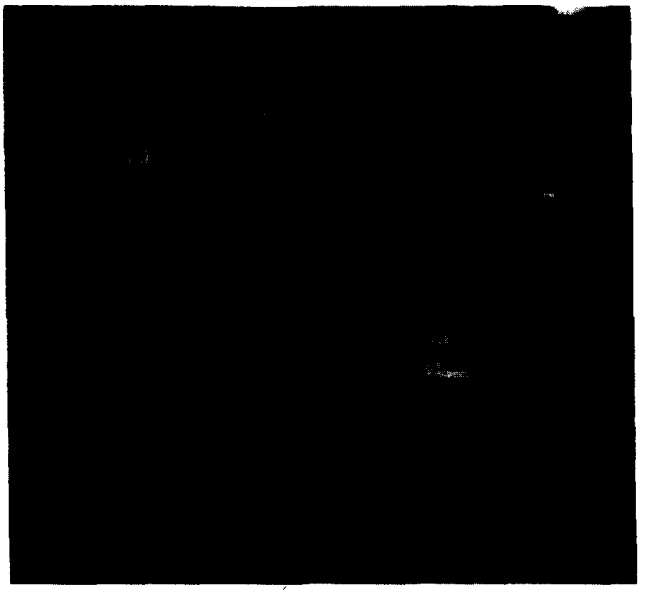
- **The time delay between the scanning of the odd lines and the scanning of the even lines causes blur in an interlaced image.**

- **Every other line is out of register by the amount of the movement between scans.**

- **The faster the subject or camera movement the worse the blur.**



Progressive Scan



Interlaced

- **Progressive scanning (scanning every line is sequence) minimizes this effect**

- **Every line is scanned immediately after the line above it.**

- **Interlace scanning is no longer necessary, even for high definition imagery.**

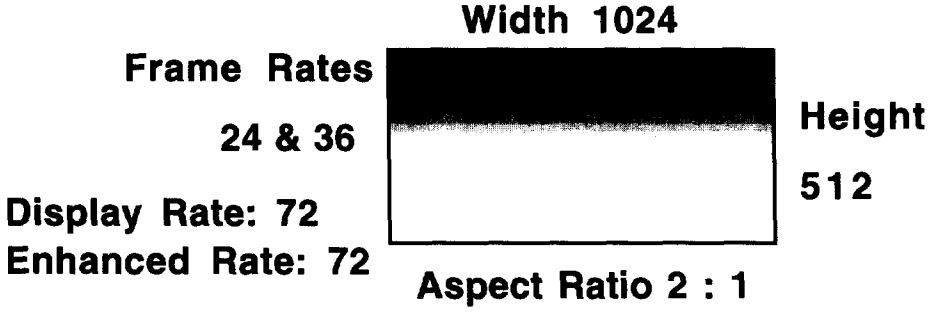
Principles For An Optimal Base Layer

- De-interlace all formats prior to layered encoding
- Convert all formats to the optimal frame rates
- Optimize the aspect ratio to maximize image area
- Optimize the colorimetry for best film and video color
- Optimize base resolution for image clarity vs. lowest cost

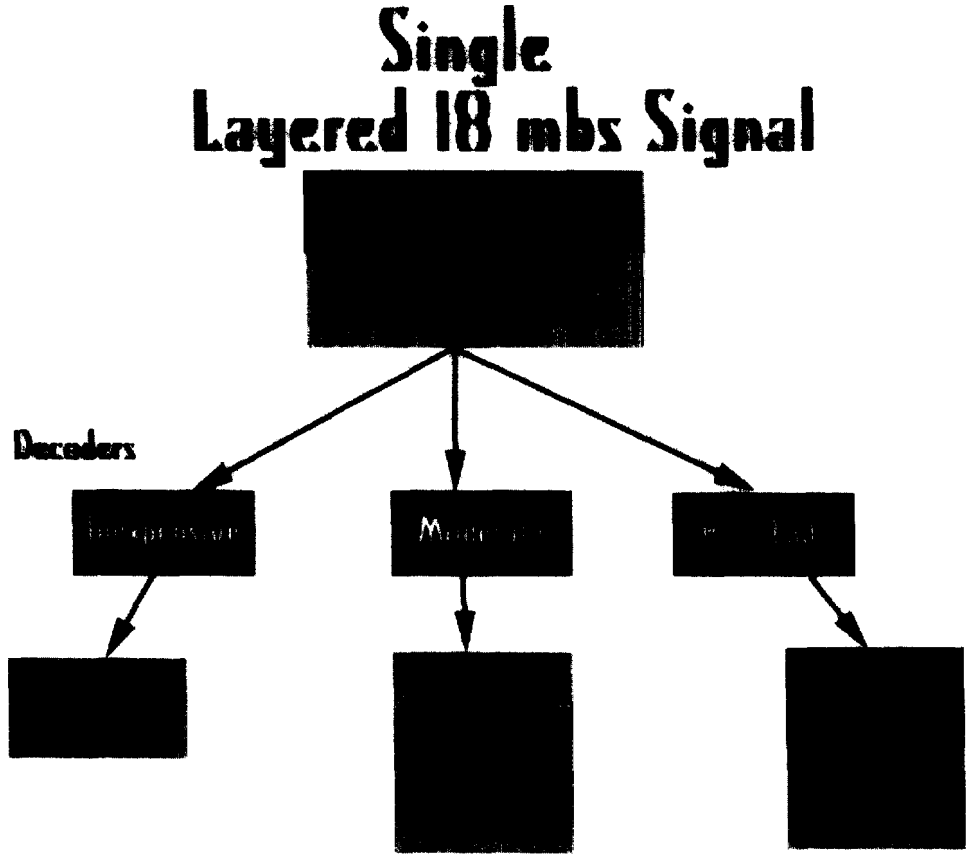
Primary Issues to consider:

- Cost of decoder memory
- Cost of decoding rate
- Cost of receiver conversions (minimized wherever possible)
- Perceived quality of the image at common screen sizes
- Smoothness of motion for sports
- Usefulness and perceived quality of base temporal rate layers

These considerations have lead us to recommend the following properties for the Base Layer:



From A Common Signal, Multiple Quality Levels



• The idea behind Layered Compression is that there are two layers in the broadcast signal.

•The first can be called the base layer and is the layer that is used to display the video image on both inexpensive and high-end receivers.

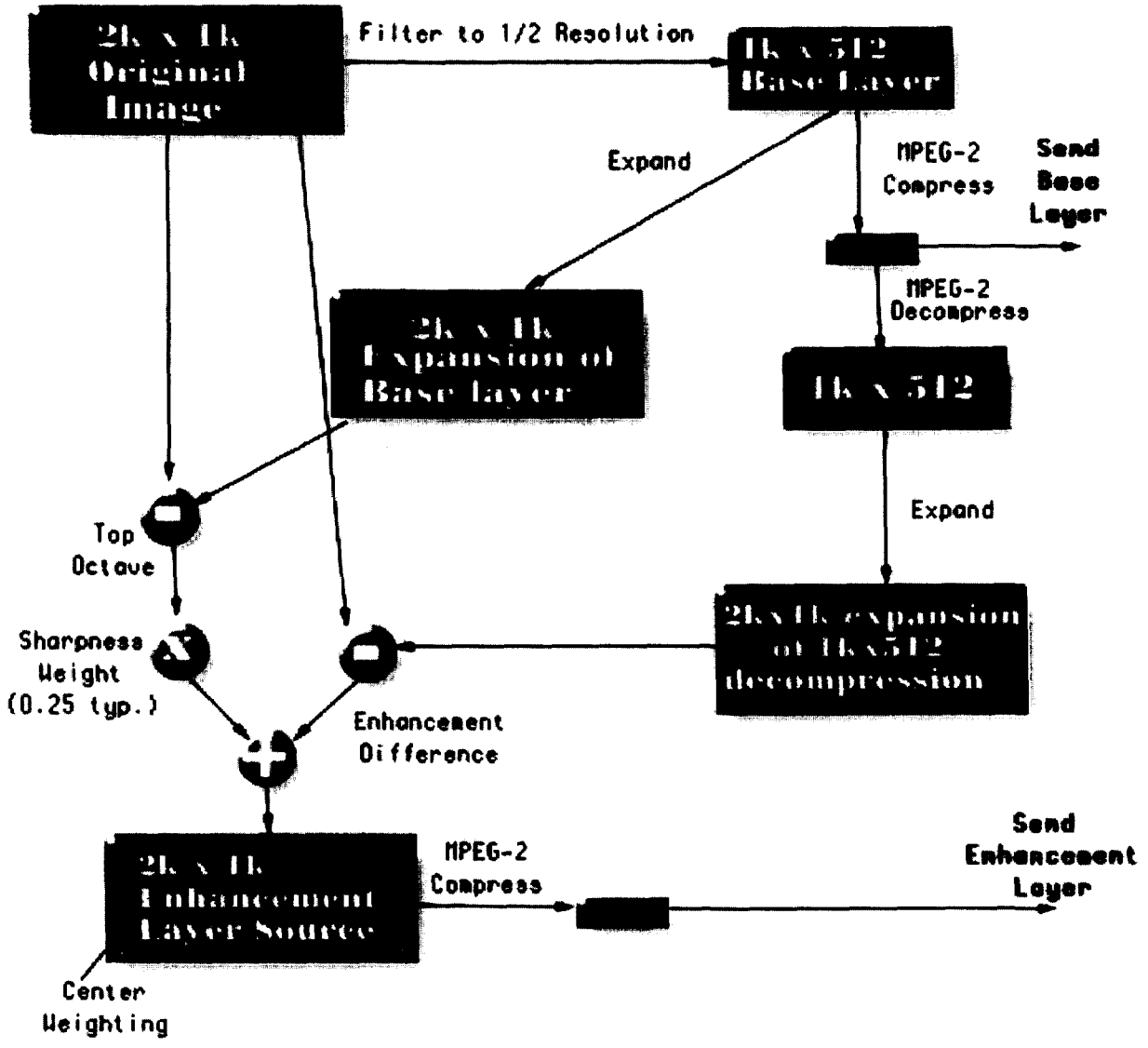
• The Enhancement layer is used only by the high-end receiver to enhance the image both spatially and temporally.

• A properly designed layered system can be achieved with no inefficiency.

• There are added benefits to a layered system.

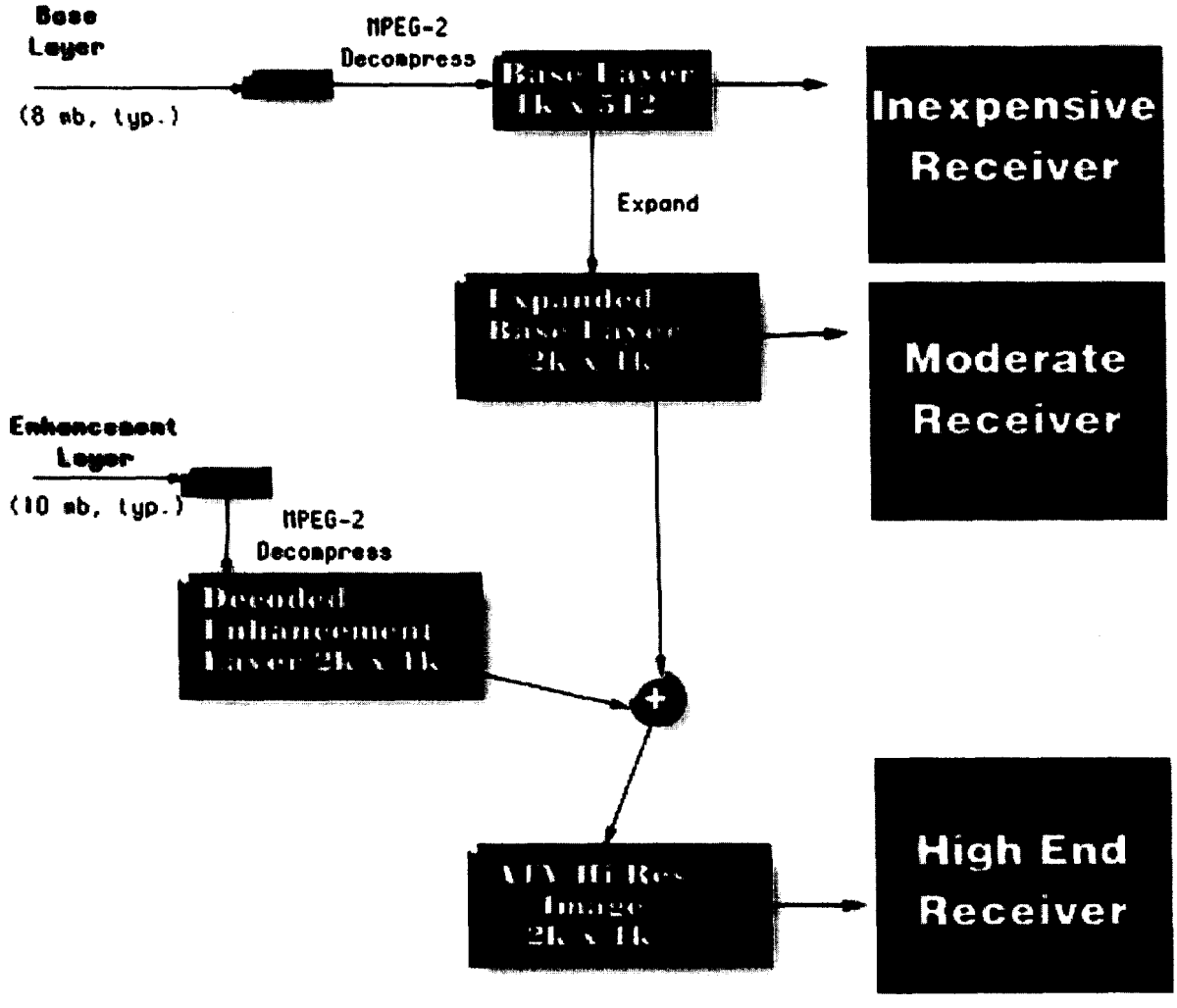
Encoding of Spatial Layered Compression

The Encoding Process Uses MPEG-2 To Extract The Base and Enhancement Layers

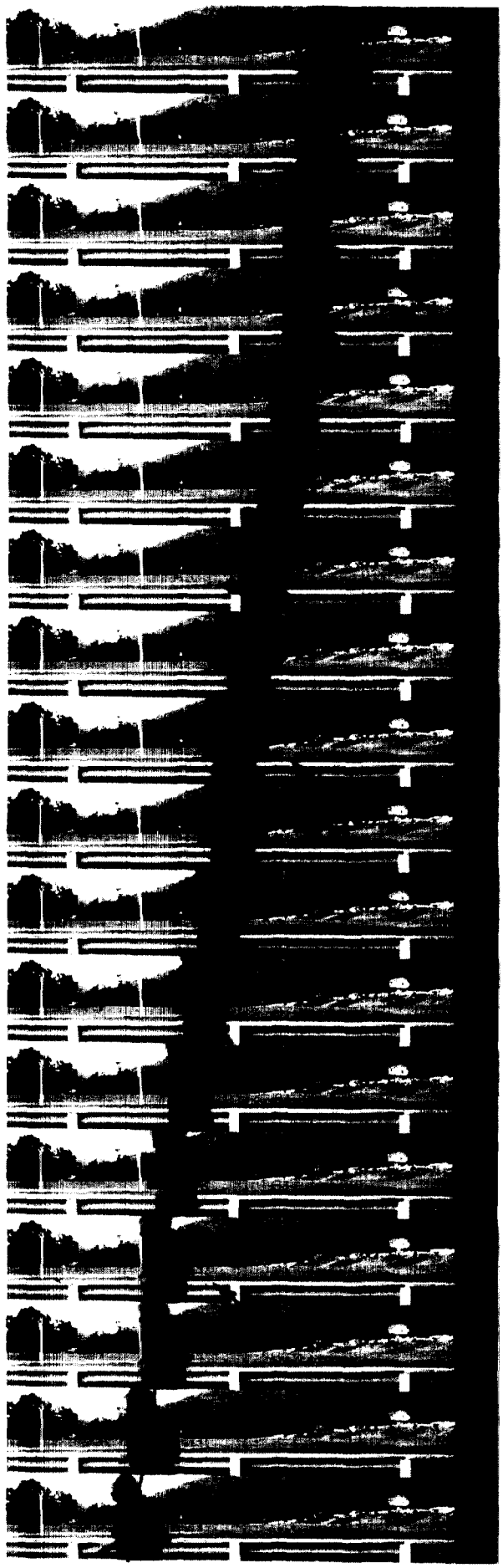


Decoding of Spatial Layered Encoding

The Decoding Process Adds Blocks Of Capability To Provide Multiple Levels Of Image Quality



This sequence of frames shows the frame-repeat pattern which is required to convert 60 Hz images for 72 Hz display



The Frame Rate Of The Base Layer Must Also Be Considered

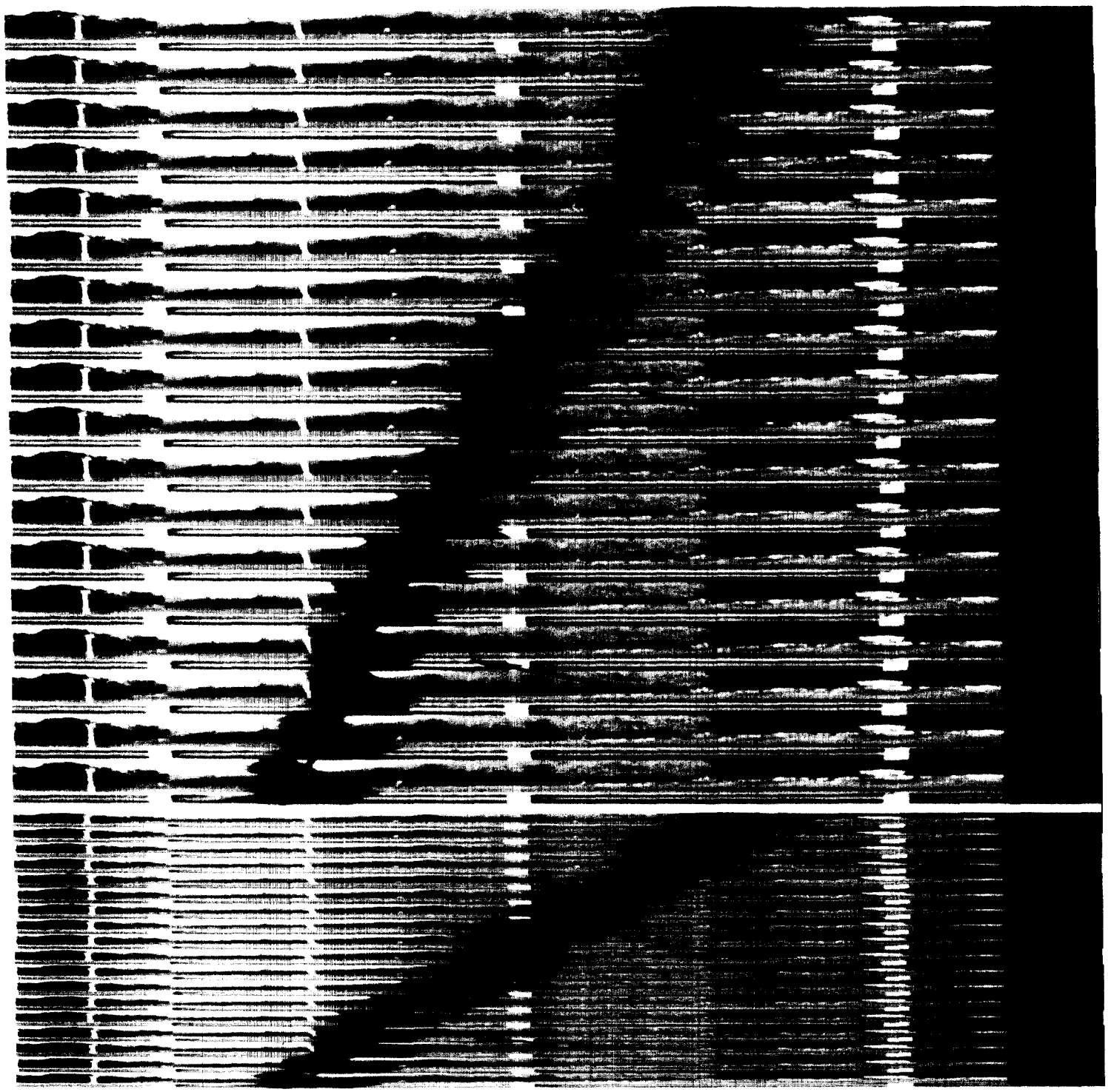
This frame-repeat technique is embedded in the ACATS proposal and in their cost estimates

Every fifth frame must be repeated to create a duplicate sixth frame

60 Hz Results In Motion Stutter

When viewed close together, the frame stutter is easily seen. This stutter will appear as a motion artifact. Any images at 60 Hz will exhibit this motion stutter. The motion will be jerky and uneven. This defeats the entire purpose of using a high frame rate such as 60 Hz. Thus, computer displays, which operate at rates exceeding 70 Hz, will look inferior on fast motion images such as sports.

DemoGraFX avoids these problems by basing our system on the frame rates of 24, 36, and 72 Hz, which will all appear optimally smooth on the 72 Hz display.



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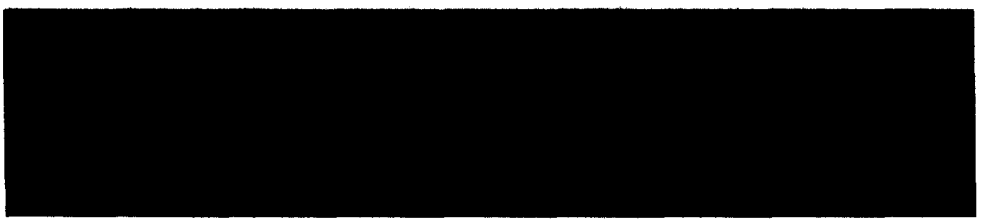
There are three important types of frames in MPEG-2 compression. They are:



- The B frames require a more expensive decoder.

- No B frames are used in the base layer.

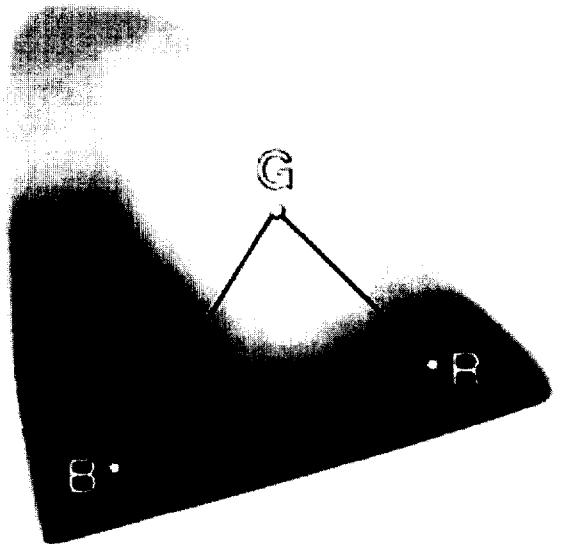
- The Enhancement layer would add B frames to a 36 frame per second base layer to yield a higher temporal rate of 72 Hz.

The Base layer would then look like this:

The Temporal Enchancement Layer would look like this:

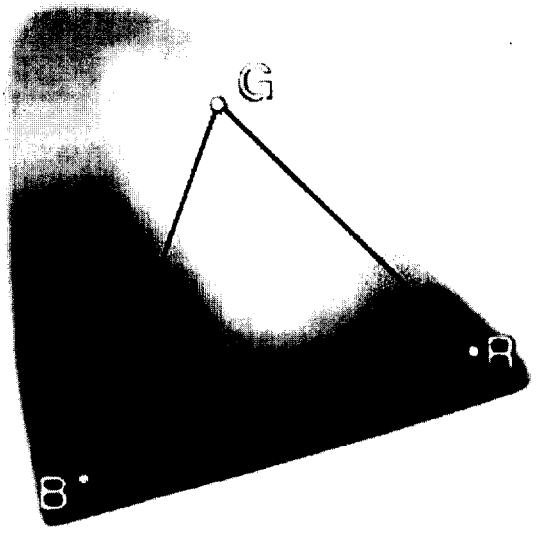
The combined Base and Temporal Layer would look like this:

COLORIMETRY



ATV COLORIMETRY

• This is the approximate colorimetry mapping of the proposed ATV Standard.

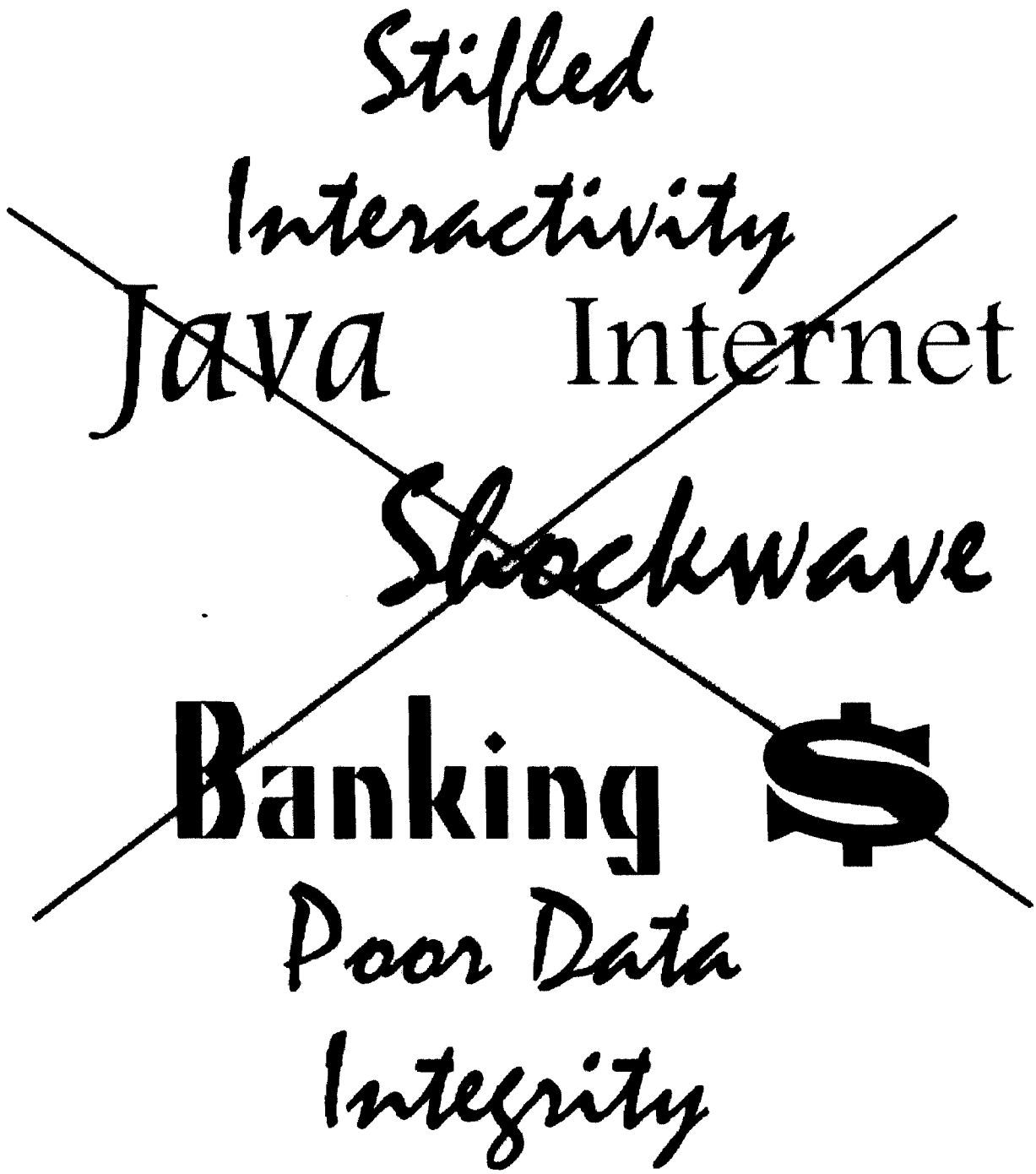


FILM COLORIMETRY

• This is the approximate colorimetry mapping of 35mm film. Notice the expanded color space.

Data Integrity

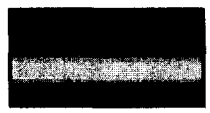
- The ACATS proposed error correction scheme for the MPEG-2 transport layer does not supply adequate error correction for most interactive, banking, and NII applications.



Comparison of Layered System vs. ACATS

Layered ATV

"Base Layer"



1024 x 512

2 : 1 Aspect Ratio

Rates: 24, 36, 72

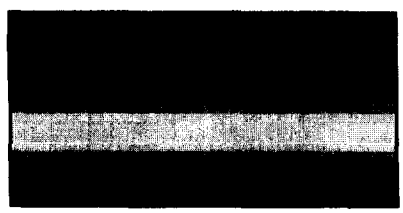
Amount Of Image: 1/2 MPixel

Base Layer

"Plus"

"Enhancement Layer"

"HDTV"



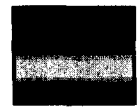
2 : 1 Aspect Ratio

Rates: 24, 36, 72

Amount Of Image: 2 MPixels

ACATS ATV

"SDTV"



640 x 480

704 x 480

4 : 3 Aspect Ratio

704 x 480

16 : 9 Aspect Ratio (stretched)

Rates: 24, 30, 60i, 60p

Amount Of Image: 1/3 MPixel

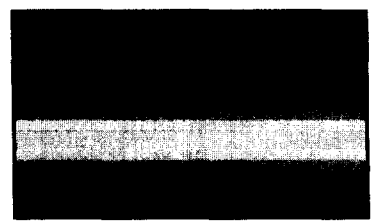
"HDTV"

1280 x 720

16 : 9 Aspect Ratio

Rates: 24, 30, 60p

Amount Of Image: 1 MPixel



1920 x 1080

16 : 9 Aspect Ratio

Rates: 24, 30, 60i

Amount Of Image: 2 MPixels

Other Differences With ACATS

What we can keep from the work of ACATS:

- Modulation
- First Two Layers of Error Correction
- Transport Packets for Audio & Video
- Audio
- 24 Frame-Per-Second Image Rate
- MPEG-2 As The Basic Compression Technology
- Video Colorimetry Specification

What we have discarded from ACATS work:

- 23.98, 29.97, 30, 59.94, and 60 Hz Image Rates
- 4:3 and 16:9 Aspect Ratios
- Interlaced Formats
- Non-Square Pixel Spacing Formats (704 x 480)
- Image Formats (640 & 704 x 480, 1280 x 720, 1920 x 1080)
- The MPEG-2 Profiles and Levels (which are tied to interlace)

We have replaced these elements with:

- 36 and 72 Frame-Per-Second Image Rates
- 2 : 1 Aspect Ratio
- Base Layer Format (1024 x 512)
- Enhanced Layer Format (2048 x 1024 Result)
- Progressive Scan In All Formats

We also propose adding:

- An Additional (Third) Layer of Error Correction
- An Additional Computer-Like Packet Structure
- Overlay Planes (For Persistent Text & Graphics)
- Film Colorimetry

In Summary:

- ATV can become a key enabler for the N.I.I.
- ATV is NOT just about broadcast TV of news and sports
- A layered ATV system offers quality and cost advantages
- The base layer provides a cost-effective stepping-stone to HDTV
- Interlace prevents efficient layering
- Our base layer is similar to the ACATS SDTV progressive formats
- However, DemoGraFX has optimized the base layer
- The DemoGraFX base layer is ***much*** higher quality than NTSC
- The base layer is fully computer compatible
- The enhancement layer provides computer-compatible HDTV
- DemoGraFX is demonstrating full progressive scan, layered HDTV
- We are exceeding the ACATS goal of 1920 x 1080 at 60p.
    - — We have already achieved 2048 x 1024 at 72p !
    - — And it is layered upon a very high quality base layer